From the Desk of Guest Editor

Govt. of India has an ambitious plan of construction of roads, railways and waterways for improved connectivity to different regions of India and for defence of the country. Innumerable bridges and culverts are required for drainage and communication purpose. Apart from sound structural design of superstructures and foundation for safety of the bridges, a lot of morphologic, hydrologic and hydraulic investigations are needed for determining the location, waterway, afflux, scour protection and river training measures. In this special issue of the journal, containing ten papers on the subject, I have discussed the above mentioned broad aspects of bridge design in the first paper,. Some of the provisions made in existing IRC codes, especially for scour computation, have been critically examined with a view to further improve the relevant codes.

Determination of scour around piers and abutments is one of the important criteria for deciding foundation level of a bridge. Most of the bridge failure occurs due to scour and inadequate foundation. Geotechnical investigations for bridge foundation is needed to explore the foundation materials and decide type of foundation, scour, bearing capacity and foundation level. In case of Passighat bridge, it took about 10-12 years for construction of foundation only, perhaps due to negligence in proper geotechnical investigations. With bore hole data, these geo-technical aspects have been highlighted in the second paper by Madhira. Although scour is governed by several parameters e.g. pier shape and size, gradation of sediments, flow geometry, flow obliquity, none of these parameters is considered for scour estimation in IRC method (IRC-5/IRC:SP:13/IRC-78) based on Lacey's regime theory. The codes do not distinguish between clear water and live bed scour. Unlike Lacey's cquation, where scour goes on increasing with flow, maximum scour depth remains the same once river bed becomes live. Scour depth in gravelly and bouldery river beds is considerably less than that estimated by IRC method.

IRC codes prescribe maximum scour depth below HFL as $2d_{sm}$ where d_{sm} is the regime scour depth found by Lacey's regime equation at design peak flood. The multiplication factor 2 has been adopted by IRC from a CWPRS/CBIP publication [1] based on measurements of maximum scour depths in 17 bridges in lower Ganga river where sediment size varied from 0.31 mm to 1.3 mm. Maximum scour depths were found to vary from 1.85 d_{sm} to 2.15 d_{sm}. There is no mention of return period or frequency of flood when the measurement were made. In the third paper, Machhkhand found total scour depth for foundation design of a RO-RO at Sahebganj on Ganga river as sum of general scour, contraction scour and local scour. Several mathematical models are used to determine all the three components of total scour. The total scour below HFL determined by Mellvile-Coleman model was found to be 24.5m as against 36.88 m by use of IRC method.

Several remedial measures[2] e.g. collars, slits, vanes, garlanding etc. have been developed for arresting/reducing/controlling scour in bridge piers. Bongirwar in his fourth paper has discussed about use of garlanding in gravelly and boulder rivers. Details of garlanding e.g. size, thickness etc. successfully used in several bridges on boulder and gravelly rivers by BRO have been outlined. Local and total scour depths in gravelly/bouldery bed determined by several mathematical models including Lacey's model have been tabulated for 7 bridge piers. It shows that scour depths computed by Lacey's model far exceed those determined by mathematical models.

Considering the different parameters governing scour, number of eminent researchers (e.g. Kothyari-Garde-Raju, Richard and Davis, Dey , Melville and Coleman, Raudkivi and others from India and abroad have developed several mathematical models for scour estimation by using both flume and field data. In the fifth paper, Ahuja has worked out several examples to illustrate that scour estimated by IRC method exceeds those found from HEC-18 model. He is of the view that existing IRC method should be reviewed and replaced by mathematical models mentioned above. Unfortunately, BIS, IRC and RDSO codes continue to follow Lacey's equations developed in 1930 for scour estimation in bridges.

Most of research works on bridge pier scour is directed towards estimation of maximum scour depth that occur near pier nose. Very limited study is available on extent of scour at different stages of scour development. In the sixth paper, Narayan et al measured extent of scour and quantify the scoured material at 25%, 50%, 75% and 100% of maximum scour that occurs in pier under clear water condition. Ultrasonic sensing system with transducers was used to measure the scoured bed elevations in the experimental flumes to find the areal and volumetric variations of scour at different stages mentioned above. MATLAB software was used to explore scour hole geometry at different stages of scour development.

When the flood plain width of a river is very large due to river meandering as observed in most of the Himalayan rivers in the northern peninsula , it is economical to restrict the meander belt by providing guide bundhs. In the seventh paper, Korrula et al has discussed about the protection measures adopted in Delhi-NOIDA toll bridge by using Zinc-coated wire mesh gabions for safety of foundation, guide bunds and approach embankments. Different criteria to find the size of gabions have been outlined.

It is well established by both flume and field study, that local scour depth (y_s) in a pier is governed principally by pier size (a) and sediment size (d_{50}).in well graded (σ <1.3) fine soil. In coarse soil like gravels and boulders etc.(σ>>1.3), however, local scour is considerably reduced due to armouring effect. Fig.1 illustrates variation of local scour depth (y_s/a) with (σ) for different sediment size.[3,4]. Here σ is the non-uniformity co-efficient of soil given by the relation $\sigma=(d_{84}/d_{16})^{0.5}$. Ahmed and Pandey in their eighth paper have discussed about the local and total scour variation in fine and coarse bed material. With 441 lab and 760 field points, they have computed the errors (SSE and SSEN) using different mathematical models and concluded that Sheppard & Miller model and HEC-18 model gave the least error. Authors suggested that the IRC model of scour estimation should be discarded since it does not include the effect of pier size and coarseness of sediments on scour and it does not distinguish between clear water and live bed scour.

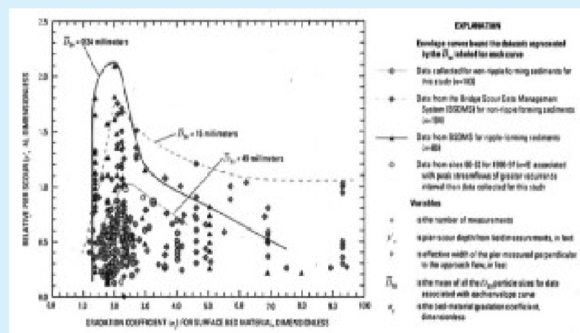

Fig.1 Showing Variation of Local Scour, y_s/a Below Bed with Size and non-uniformity (σ) of Bed Materials

Scour measured in distorted physical models in laboratory flumes can not be directly converted to prototype scour because of scale effects. In the ninth paper, Ahmad et al used three different mathematical models to determine maximum scour depth in prototype bridge piers by using observed maximum scour around piers measured from physical model. The bridge is 9.759 km. long constructed on Ganga river located about 10 km downstream of existing Gandhi Setu near Patna in Bihar. It is observed that the computed scour depth by Melville and Sutherland equation is higher than Froehlich method followed by Kothyari et al. model. The scour depth computed using the scaling of Melville and Sutherland equation and Lacey equation was comparable. It was concluded that Melville and Sutherland equation for the estimation of maximum scour depth may be used to convert the scour depth observed in the model to the corresponding maximum scour depth in the prototype structure.

Scour in piers and abutments in a bridge is prnicipally determined by flood magnitude which governs the waterway, afflux, erosion and protection measures also. Design flood for all bridges is determined by flood frequency or return period of peak flood which is universally accepted as 100 year. Sinha in his tenth paper has discussed various methods e.g. empirical method, Rational method, synthetic unit hydrograph (SUH) method for computing peak flood discharge for given catchment using rainfall data. For direct determination of flood, Area-velocity method, use of existing hydraulic structures and probability distribution method (e.g. Gumbel, Log Pearson etc.) have been recommended.

All mathematical models for scour estimation should be proved by prototype measurement of scour as in HEC-18. Unfortunately, after Lacey, Inglis in 1930s, there is hardly any such field data in India. In most of the papers, pier size (a or b) is assumed to be uniform. There are numbers of bridges where piles or wells are used. Mellvile and Colema (5) suggested how to find equivalent size of pier (a or b values) in case of such compound foundation.

REFERENCES:

1. CBIP, "River Behaviour, Management and Training", pub. by Central Board of Irrigation and Power, Chanakyapuri, New Delhi,1999
2 Singh,N.B,, Devi,T.T. & Kumar,B. "The local scour around bridge piers-review of Remedial techniques" pub.in ISH J. of Hyd. Engg., April.2020
3. Mazumder, S.K. and R.K. Dhiman "Local Scour in Bridge Piers on Coarse Bed Material- Observed and Predicted by Different Methods", paper presented and pub. in the J. of Indian Roads Congress during the annual session at Bhubaneshwar, 2014.
4. Holnbeck " Investigation of Pier Scour in Coarse-Bed Streams in Montana, 2001 through 2007"- Scientific Investigations Report 2011–5107, by U.S. Department of the Interior, 2011
5. Melville,B.W. and Coleman, S.E. "Bridge Scour",Vol.I and II,'Water Resource Publication,LLC, Colorado,USA, 2000

Brief Profile of Guest Editor

Born in 1938, Prof.S.K. Mazumder graduated in Civil Engineering in 1959 from B.E. College, Shibpur, Calcutta University (now IIEST,Shibpur). He was Assistant Engineer,(Irrigation & Waterways Dte), Govt. of West Bengal, during 1959-62. He obtained his M.Tech. and Ph.d.in Civil Engg (Dam &Hydro-power Engg) from IIT, Kharagpur where he was a lecturer during 1962-67. He was Assistant professor in Civil Engineering at R.E.C.(now NIT),Durgapur, during 1967-75 and Professor of Civil Engineering (Hydraulics & Flood Control) at Delhi College of Engineering (now Delhi Technology University), during 1975-98. He was AICTE Emeritus Fellow during 1998-2000. During Feb-Nov, 1991, he was a visiting professor at EPFL, Switzerland. He was Head of Civil Engg. and Dean of Faculty of Technology, University of Delhi. He is Fellows of CBIP, IE(I), ISH &IWRS and member of IAHR, IRC, ISCA, IPHE, CDC, CEAI. He was principal Investigator of several research schemes sponsored by a number of Govt. and Pvt. Organizations.

Prof. Mazumder has published/presented more than 200 technical papers in National and International journals and confereces, written two books, editor in chief of the proc. of national conf , contributed a chapter in two books by Kleuer and Springer publications. He got several awards for his papers from the Institution of Engineers (India) and Indian Roads Congress. He received life time achievement award in 2009 and best Reviewer Award in 2019 and 2020 from Indian Society for Hydraulics for his immense contribution in hydraulics and water resources Engineering

After retirement, Prof. Mazumder served several consulting companies in Delhi e.g. ICT Pvt. Ltd., Aquagreen Engg. Pvt. Ltd, Scott-Wilson-India Pvt. Ltd., Mahendra Raj Consultants, B&S Consultants, NOIDA, Rambol India, Infinite Civil Solutions, Ahmedabad and retained by Maccaferri India, Gurgaon. in the area of his specialization i.e. Hydraulics and Water Resources Engineering. He is currently, a faculty member of Indian Academy of Highway Engineers (IAHE), NOIDA. He is Member/convener of several committee of IRC and BIS, Govt. of India. For three years, he was an expert member of EAC (Hydro & Irrigation group) , Min. of Env. & Forests, Govt. of India. He was a member of NIH Society, Roorkee, as a nominee of the Minister of Water Resources, Govt.of India. He is a reviewer of several journals published by several societies e.g. Institution of Engineers(India), Indian Society for Hydraulics, ASCE, IRC etc.

Further details are available in his web site www.profskmazumder.com